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for CECS Level II Coaches

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SPECIFIC THEME: Practical aspects of cross-training

GENERAL THEME: The basics of cross-training

Specific Theme

PRACTICAL ASPECTS OF CROSS-TRAINING

1 Introduction

Since the early 1990s, the number of athletes using cross-training to help them improve their primary-sport performance and maintain all-around conditioning has been booming.

> Cross-training can be defined as using another sport, activity, or training technique to help improve performance in the primary sport or activity (Moran & McGlynn, 1997, pp. 3-4).

2 Developing a cross-training program

2.1 Reviewing training goals

To get the most out of cross-training, the athlete should first review the goals and objectives of his or her training program. This also includes assessing one's strengths and weaknesses in one's sport or activity and the specific demands of one's sport. Then the athlete should look at which cross-training activities could be added to the program to enhance his or her overall potential. The cross-training program will depend on the training goal one wishes to establish and one's present athletic ability.

2.2 Integrating cross-training into the training program

Athletes might want to cross-train on the same day they train for their primary sport (for example, athletes might work on flexibility and agility cross-training along with their primary-sport training in the morning and cross-train with plyometrics in the afternoon), while at other times, they may want to cross-train on off-days from their primary sport.

Depending on their specific needs, athletes may also substitute the type of cross-training exercise. A runner, for example, who is having some leg or joint problems, might substitute aqua jogging or cyling for *StairMaster* or *VersaClimber*. Athletes should feel free to experiment with different cross-training exercises until they find a comfortable fit for their sport and body.

During pre-season and in-season, an athlete's primary-sport training program may require 80-90% of the total training time, with the remaining 10-20% being spent on aerobic and anaerobic cross-training activities. During the off-season, however, athletes may want to focus more on cross-training, perhaps to avoid boredom or the chance of overuse injury. Of course, an athlete's training emphasis will change as his or her goals and needs change. For instance, a sprinter may wish to focus on increasing leg strength in the off-season by shading his or her program toward strength training. Now 40-50% of his or her training total may consist of cross-training activities for increasing muscular strength and power.

A general principle to follow in determining one's overall training mix is first to evaluate the type of demands one's sport places on one's body. These demands determine the type of adaptation that has to take place. For example, athletes involved in high-speed events such as sprint running should focus their program on strength and power training that requires muscular demands similar to that of the actual event. As athletes near the competitive season, their training should become more specific to their primary sport with cross-training making up approximately 25-30% of the weekly program.

During the off-season and in the early part of the training season, cross-training activities may make up as much as 50% of one's training total. An exception is rehabilitation cross-training, which may require a greater percentage of the total. For example, a distance runner with a hairline fracture may depend heavily on aqua jogging to maintain aerobic endurance and reduce the stress on the injury (Moran & McGlynn, 1997, pp. 75-76).

2.3 Sample cross-training program: Long-distance running

The primary goal of a 50-miles-per-week runner whose goal is to run a marathon in a target time of under 2:30 hours might be to increase his aerobic endurance. Other goals might be to increase muscular strength and endurance and improve flexibility and agility. Although most sub-2:30 marathoners train an average of at least 80 miles per week for twelve weeks prior to the race, a runner may not be able to work up to such mileage due to weather conditions, tendency for injury with high mileage, or training schedule limitations. Instead, this runner could benefit from adding cross-training activities to his program.

Aerobic capacity may be improved by using a number of cross-training activities, the most effective for runners being cross-country skiing, bicycling and aqua jogging. Depending on the intended weekly mileage, a runner might want to alternate aerobic cross-training days with his primary-sport training days, or combine cross-training and running on his lighter days. To increase one's aerobic fitness, it is important to cross-train within one's target heart range for the duration of the exercise session.

Although marathon running depends primarily on the delivery of oxygen to the muscles via the aerobic energy system, competitors must also have the ability to sustain an anaerobic sprint at the end of the race. Therefore, anaerobic exercise should comprise approximately 5% of the total training time for marathoners. An effective means for promoting anaerobic endurance is interval training, where work periods of 30 seconds, 1 minute, and 2 minutes are alternated with recovery periods ranging from 1-15 minutes. A marathoner may wish to interval train with running or try some cross-training activities such as working out on the treadmill, cross-country ski machine, and *VersaClimber*.

Strength training is important for the marathon runner to maintain proper stride and prevent muscle fatigue. A strength program of three days per week where the focus is on the hips, legs, and upper body will help to prevent injury and increase strength and endurance. Shoulder and arm strength are especially important in preventing fatigue late in the race.

The selection of the flexibility exercises for each sport is especially important. By increasing the range and extent of movement through stretching, an athlete is better able to move from one exercise to another without increasing his or her chances of soreness or injury. Swimming and aerobic dance are good ways for long-distance runners to maintain and increase flexibility (Moran & McGlynn, 1997, pp. 76-79).

3 Cycling for making runners faster and stronger

In 1984 Joan Benoit Samuelson suffered from a knee injury. When she required surgery just two-and-a-half weeks before the Olympic Marathon Trials, she could not run a step for several days. Frustrated but unwilling to surrender her Olympic dream, Samuelson trained furiously on an exercise bike, won the Trials and went on to win a gold medal.

Although skeptical exercise physiologists did not think that cycling was specific enough, that it did not use the same muscular patterns as running, research supporting the bike-to-run-faster theory began to appear from various scientific laboratories. One study showed that experienced runners who substituted cycling workouts for running improved their quadriceps muscle strength by 20% in only four weeks. Since stronger quadriceps muscles boost a runner's ability to perform well on hilly courses, the results showed how cycling could make already-fit runners even fitter.

To complete his master's degree in exercise physiology at Brigham Young Universiy, Ted Eyestone – the two-time U.S. Olympic marathoner – designed a study to measure the effects of bicycling and pool running on runners. He began by having 32 runners complete a 2-mile race to measure their baseline fitness. Then he divided the runners into three groups: 11 of the runners continued their regular run training for the next six weeks; 10 trained only on exercise bicycles; and 11 trained by running in a pool. At the end of six weeks, the 32 subjects completed another 2-mile race. It turned out that all three groups improved their times by an average of 1%. In other words, bicycling (and pool running) had helped – not hurt – running performance. Indeed, it was just as effective as regular run training.

Further support for bicycling comes from Tom Miller's doctoral research in exercise physiology at the University of Utah. Intrigued by the specificity question, Miller set out to design bicycling workouts that mimicked running. He did this by asking his subjects (runners of average ability) to get up out of the saddle and perform "standing bike intervals".

First, Miller's subjects ran a 10-K time trial. Then, for the next six weeks they did standing bike intervals once a week. During these intervals, which lasted from 30-60 seconds, the subjects stood up on their bike pedals and maintained a cadence of 75-90 rpm against heavy pedal resistance. Between intervals, they recovered with about 75 seconds of easy pedaling. These standing bike intervals were performed on bikes from which the toe clips had been removed. This ensured that the main muscular work came from pushing down on the pedals, not pulling up with the clips. The idea was to make the standing bike interval much like hill running.

After six weeks the subjects ran another 10-K time trial. They improved the average time they had achieved in the first trial (47:09) by about 9% (43:07).

This shows that at least with runners of average ability cycling workouts can add speed and strength to one's running (Anderson, 1994, p. 97).

According to Anderson (1994, p. 97), runners who decide on supplementing their run training by bike workouts should follow two guidelines:

(1) The standing bike intervals should be done once a week on an exercise or an outdoor bike with the toe clips being removed. If on an indoor bike, the athlete should warm up for at least 10 minutes. Then he or she should stand up out of the seat and pedal at a cadence of at least 80 rpm for 60 seconds. After 60 seconds, the athlete should sit down, reduce the resistance and pedal easily for 2-3 minutes. The sequence should be repeated 6-10 times. If bicycling outdoors, warm-up should be done by riding easily to a lightly traveled ascending road. Then the athlete should stand up and power his or her way up the hill for 30-60 seconds before turning, gliding back down and pedaling easily until 2-3 minutes have elapsed. Then the hill should be attacked again. The sequence should be repeated 6-10 times.

(2) To improve his or her VO_2max, the athlete can do longer intervals on a bike, pedaling for 4 minutes at an intensity that feels like his or her 5-K race pace (90% of maximum heart rate). Recovery should be done with 3 minutes of easy cycling. Then 3-5 more long intervals should be done followed by recoveries.

Standing bike intervals can increase quadriceps strength, improve VO_2max and help run faster and stronger (Anderson, 1994, p. 97).

Typical Cross-training Week for Runners (5,000 to 10, 000 meters) (O'Shea, 1990, p. 42)		
	a.m.	**p.m.**
Monday	**Weight training, heavy intensity** **IT-run, 45 min**	**Bike, LSD, 60 min**
Tuesday	**Run, LSD, 75 min, recovery swim, 15 min**	
Wednesday	**Weight training, light, 30 min**	**Bike, IT, 30 min**
Thursday	**Running at varied pace on hills, 60 min**	**Swim, IT, 20 min**
Friday	**Weight training, medium intensity, 45 min** **IT-run, 30 min**	**Bike, LSD, 60 min**
Saturday	**Run training, 40 min**	**Bike, LSD, 60 min**
Sunday	**Recovery swim, 20 min**	

LSD = Long, Slow, Distance
IT = Interval Training

Typical Cross-training Week for Throwers		
(O'Shea, 1990, p. 43)		
	a.m.	**p.m.**
Monday	**Weight training, heavy intensity** **Olympic lifts: power snatch, power cleans, pulling movements, push press**	**Specialized plyo-metrics for arms and shoulders using pendulum instruments** **Medicine ball throws**
Tuesday	**Sprinting – 15-30m** **Accelerations – 60-80m, (top speed between 20 and 30 meters)** **Hurdling 3 to 5 hurdles**	**Stationary cycling, 10 to 15 min of IT** **Recovery swim, 15 min**
Wednesday	**Weight training: squats, heavy front and back and lower back work**	**Implement throwing, lighter and heavier than competitive weights**
Thursday	**Weight training, same as Monday, only light**	**Same as Monday**
Friday	**Same as Tuesday**	**Same as Tuesday**
Saturday	**Weight training, same as Wednesday (light to medium)**	**Same as Wednesday**
Sunday	**Recovery swim, 20 min**	
IT = Interval Training		

General Theme

THE BASICS OF CROSS-TRAINING

1 History of cross-training

Although the term *cross-training* first occurred around 1980, this term has roots that date back to the late 1940s and 50s where the term cross-education was brought to the fore. Under the work of F. A. Hellebrandt and her colleagues, work was done which suggested that a general motor (neurological) learning effect results when training just one limb. Cross-education researchers observed that when the brain signals the arm or leg to contract, it flashes a similar signal to the opposite inactive limb, apparently as a protection against the dangers of fatigue. Obviously, the opposite limb does not necessarily respond to this signal (limbs can function independently of one another), nevertheless, it gets the same message. Hellebrandt did caution, however, that cross-education improved only the signal from the brain to the muscle, but did not observe any physical condition of the actual muscle tissue (Town, 1989, p. 34).

2 Definition of the term *cross-training*

Lately cross-training has become a highly popular term most often associated with the training of triathletes. In general, cross-training involves more than one type of activity to exercise different muscle groups and provide variety. A runner, for example, in addition to running may include cycling and swimming in a program of cross-training. The term is also applied to training multiple fitness components (e.g., strength, flexibility, and endurance) within the same training session (Kent, 1998, p. 132).

Cross-training refers to training for more than one sport at the same time or training for several fitness components (such as endurance, strength, and flexibility) at one time. The athlete who trains by swimming, running, and cycling in preparation for competing in a triathlon is an example of the former, and the athlete involved in heavy resistance training and high-intensity cardiorespiratory training at the same time is an example of the latter (Wilmore & Costill, 2004, p. 298).

The cross-training concept is in direct opposition to a well-founded principle in sport called specificity (Molyneux, 1992, p. 1).

3 Sports-specific training

The specificity principle holds that any training done to improve sport performance should duplicate as closely as possible the demands of the sport in terms of the primary energy system involved and muscle groups used, along with the force, speed, range, frequency and duration of movement. This means that for whatever sport one is competing in (strength or endurance), the performance demands are the central focus of the training program.

While the specificity principle is one of the cornerstones of athletic training, it has limitations that need to be addressed if peak performance is to be achieved, Generally, all sports require varying degrees of aerobic and anaerobic power along with strength and muscular endurance. By itself, sports-specific training does not and cannot produce peak performance. This is possible only in conjunction with training variability, which embraces the concept of cross-training.

In utilizing the sports-specific training approach, the primary performance demand is the focus of training. As an example, in endurance sports, where aerobic power is the key component, overdistance training, or long, slow, distance (LSD) training, is considered the specific training mode. On the surface, this approach may seem effective in developing aerobic power. In reality, it is ineffective in preparing the body for the total demands of peak endurance performance. LSD training simply does not develop all the key components involved in maximizing aerobic performance, such as anaerobic power, muscular strength, technical skill (performance efficiency), a sense of pace or the capacity to achieve maximal oxygen consumption. This is where cross-training enters the picture (O'Shea, 1990, p. 40).

4 Theory of cross-training

Cross-training is a holistic approach to peak performance training. The simplest way to describe cross-training is that it encompasses a complex training prescription in which two or more sports are combined into either a single workout or a long-term cyclical program.

> Cross-training differs from sports-specific training in that it allows for the simultaneous training of multiple physiological variables (e.g., aerobic and anaerobic power, strength and muscular endurance). Cross-training avoids both the boredom of single-sport specificity and the self-destructive tendency of overtraining (O'Shea, 1990, p. 41).

5 Interaction between different modes of endurance training

5.1 Similarities and differences between running, cycling and swimming

Running and cycling are the most commonly performed endurance activities. Swim training can also be considered to be endurance training as swimmers tend to have high VO_2max values and high activities of oxidative enzyme.

These three endurance exercise modes have some similarities and differences. Both running and cycling are performed in an upright position on land, whereas swimming involves a supine position in water. Similarly, the major working muscles during running and cycling are in the lower extremities, whereas the upper body muscles are the primary source of propulsive force in swimming. Of these three activities, only running is weight bearing, and is characterized by substantial involvement of eccentric contractions (Tannaka, 1994, p. 333). Pollock, Dimmick, Miller, Kendrick and Linnerud (1975, p. 144) reported equal improvements in cardiovascular function with running, walking and bicycle training regimens. They concluded that improvements in cardiovascular function are independent of mode of endurance training when intensity, frequency and duration of training were equated. This trend may hold true when task specificity of training is met. If non-specific exercise training places a greater demand on a particular parameter, a cross-training benefit might be expected (Tanaka, 1994, p. 333).

5.2 Running vs cycling

A commonly used cross-training procedure is concurrent training for running and cycling. Since both running and cycling utilize major muscles in the lower extremities, it is logical to speculate that transfer of training effects is likely to occur due to overlap of the same muscle usage. However, the quadriceps muscle group is extensively used in cycling, whereas plantar flexors are preferentially recruited in running. The enzyme activities of the vastus lateralis muscle are markedly greater in competitive cyclists compared with endurance-trained runners. Similarly, positive work generated by the plantar flexors averaged three times that done by the knee extensors during running (Tanaka, 1994, p. 333). However, during uphill running the involvement of the vastus lateralis is markedly increased, as evidenced by glycogen depletion in the muscle (Costill, Jansson, Gollnick & Saltin, 1974, p. 478).

The VO_2max values obtained on treadmills and cycle ergometers have been compared in several cross-sectional studies (Tanaka, 1994, p. 332, Table I). Competitive cyclists can generate higher VO_2max values than runners on a cycle ergometer, whereas highly trained runners can achieve higher VO_2max than cyclists on a treadmill. This tendency observed with VO_2max is also applicable to the anaerobic threshold.

Available data generally suggest that training effects gained in running are more likely to transfer to cycling than vice versa. Roberts and Alspaugh (1972, p. 6) reported that a treadmill training group demonstrated a considerable increase in cardiorespiratory function on a cycle ergometer, whereas a cycle training group exhibited little improvement on the treadmill. Pechar, McArdle, Katch, Magel and DeLuca (1974, p. 754) reported a small, but significant, increase in treadmill VO_2max (2.6%) after bicycle training. A more recent study by Nelson, Arnall, Loy, Silvester and Conlee (1990, p. 292, Table 3) also showed that intense training on a cycle ergometer for four days a week for 20 weeks produced a 20% increase in treadmill VO_2max.

It is generally concluded that adaptation following cycling training is more specific than that following running training, whereas training adaptation of running training is more general in nature (Roberts and Alspaugh, 1972, p. 10).

Two studies have examined the effects of combined run and bicycle training on endurance performance. Mikesell and Dudley (1984) studied competitive distance runners training six days a week, alternating between 40 minutes of maximal running and interval cycling. After six weeks of training, both treadmill and cycling VO_2max were unaltered. Surprisingly, the competitive runners significantly decreased their 10-K time by about 81 sec (Mikesell & Dudley, 1984, p. 373). It is not known whether the improved performance was because of the addition of cycling to the running routine or to the suddenly changed training regimen, since there was no control group.

Mutton, Loy, Rogers, Holland, Vincent and Heng (1993), using moderately fit individuals, examined the effects of five weeks of run-only vs combined run and cycle training on VO_2max and 5-K running performance. Although both groups significantly improved treadmill VO_2max (5.2 vs 5.9%) and running performance (7.3 vs 7.5%), there were no differences between the groups (Mutton et al., 1993, pp. 1395-1396).

5.3 Swimming vs running

It may appear that training adaptation may be less likely to transfer between swimming and running, as the primary muscles used in swimming and running are clearly different. The major working muscles in running are lower-extremity muscles. In contrast, the majority (>75%) of propulsive drag and lift force in swimming is produced by the arms (Tanaka, 1994, p. 335). Houston, Wilson, Green, Thomson and Ranney (1981, p. 288, Table 4) showed that swim training produced a substantial increase in enzyme activities in the deltoid, but not in the gastrocnemius muscles. It has been reported that in an untrained population, VO_2max obtained during swimming is approximately 75-80% of that obtained during running. However, trained swimmers can achieve VO_2max values during swimming that are approximately 95% of those observed during running (Holmér, 1972, p. 505).

Houston et al. (1981, p. 286, Table 2) reported that intense swim training for collegiate competitive swimmers resulted in a significant increase in VO_2max (10%) with treadmill running. However, interval swim training or swim bench training has failed to elicit improvements in treadmill VO_2max and time to exhaustion on a treadmill (Gergley, McArdle, DeJesus, Toner, Jacobowitz & Spina, 1984, p. 352).

Although studies like this imply that the transfer of training effects on VO_2max are not likely to occur from swimming to running, well trained swimmers often possess a very high running VO_2max, ranging from 3.61 to 4.55 L/min (Magel & Faulkner, 1967, p. 931, Table 3; Holmér, 1972, p. 503, Table 2; Holmér, Lundin & Eriksson, 1974, p. 712). Therefore, the possibility that long-term swim training produces central cardiovascular adaptations that may benefit VO_2max with running cannot be excluded (Tanaka, 1994, p. 335).

6 Possible benefits of cross-training

It has been suggested that training stress will be distributed to different muscles and overuse injuries may be prevented by performing multi-sport activities. For injured athletes cross-training provides a useful alternative during recovery. Hickson, Bomze and Holloszy (1977), for example, conducted a training study consisting of all-out running and bicycle sprinting on alternate days for ten weeks. The mean VO_2max linearly increased from 3.06 to 4.24 L/min without any levelling off (Hickson et al., 1977, p. 373, Table 2). The utilization of two different forms of endurance exercise may have permitted the study participants to keep up the strenuous training without causing chronic fatigue and/or joint and muscle problems (Tanaka, 1994, p. 373).

Another benefit of cross-training includes relieving the boredom commonly resulting from adherence to a single sport, by adding variety to the total training program. Cross-training provides a mental vacation without detraining or a loss of the fitness level (Moran & McGlynn, 1997, p. 5).

Cross-training also allows the athlete to perform additional work within his or her primary sport with less risk of overtraining or injury. When, for example, a distance runner who usually runs 35-40 miles a week effectively without injury attempts to increase his or her mileage to 45 miles a week, he or she will become susceptible to overuse injury. In this situation, a cross-training program can help in several ways:

- Strength training can strengthen the problem, injury-prone areas, allowing them to better withstand additional training stress.
- Activities such as cycling or swimming can provide an additional endurance training stimulus with minimal or no additional stress to these problem areas.

Warming up and cooling down with an activity such as bicycling can be a non-stressful way to improve training preparation and recovery (Moran & McGlynn, 1997, p. 5).

Conclusion: It appears that some transfer of training effects on VO_2max exist from one mode to another. The training effect seems to be more noticeable when running is performed as a cross-training mode. Swim training, on the other hand, may result in minimum transfer of training effects on VO_2max for other activities. Cross-training effects never exceed those induced by a specific training. The principles of specificity of training tend to have greater significance, especially for highly trained athletes. But even for these athletes cross-training may be an appropriate supplement during rehabilitation periods from physical injury or when suffering from mental distress (Tanaka, 1994, p. 337).

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